Original Research
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Evaluation of great saphenous vein variations with color doppler ultrasonography

GSV variation evaluation with doppler US

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Abstract

Aim: The evaluation of venous structures using color doppler ultrasonography (CDUS) has a distinctive place in both diagnosis and treatment. Because venous structures demonstrate a wide range of variations, it is important to have a good knowledge about these variations, to improve the diagnosis and treatment efficacy. The purpose of this study was to evaluate anatomic variations of the great saphenous vein (GSV). Material and Method: In this study, 500 GSVs of 250 patients who had applied to the radiology department of the Adana Numune Teaching and Research Hospital between July 2013 and October 2014, were examined by CDUS. 54 patients were males, and 196 were females. The age spectrum was 17 – 48 years and the mean age was 33.3 ± 8.0 (sd). Statistical analyses were percentage ratios and standard deviations (sd). For this study, linear transducers with a frequency range of 7.5 – 13.0 MHz, were used. Results: In the study, 4 variations at the thigh level, 5 variations at the knee level and 3 variations at the leg level, were detected. All variations were described and given with their percentages. Discussion: The anatomic variations of the GSV and their frequencies were studied. Due to its simplicity, cheapness, and effectivity, CDUS has been widely preferred for the examination and evaluation of venous structures, and it has a unique place in the diagnosis of situations concerning these vessels.

Keywords

Great Saphenous Vein; Variation; Doppler Ultrasonography

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Introduction

The GSV is the longest vein in our body, and it plays the biggest role in the venous drainage of the lower extremities. CDUS is the fundamental method of choice in the evaluation of lower extremity venous structures, and it is widely used as a simple, cheap, easy, and effective means, especially in defining the varicose alterations of these structures [1,2].

The superficial veins may have many branches, and sometimes they may demonstrate collaterals. Superficial venous structures may show variations which differ for each person [3]. It has been shown by many recent studies that lower extremity veins may demonstrate a wide range of variations including mainly the presence of accessory veins and branchings [4]. Possessing a thorough knowledge of these variations is not only essential in the defining of venous pathologies, but also of utmost importance for proper planning and execution of minimally invasive therapeutic alternatives.

The purpose of this study was to detect and define the anatomic variations of the GSV.

Material and Method

This retrospective study was conducted at the radiology department of University of Health Science, Adana Numune Teaching, and Research Hospital, and it comprises cases examined between July 2013 and October 2014. The patients were evaluated in terms of variations of the great saphenous vein. The study is statistically a descriptive work.

500 legs of 250 patients were included in the study. Each lower extremity was considered as an individual case. The patients were randomly selected and composed of 54 males and 196 females. All patients applied to the radiology department for CDUS examinations of their lower extremity veins. The majority of the patients had venous insufficiency symptoms, while some presented with leg pain, swelling, and edema. No patient had a history of GSV surgery, and this was the selection criteria to include the patients into the study.

CDUS Technique

The examinations were performed with 7.5 – 13 MHz transducers of three different brands of US machines. These were the Mindray DC – 7, GE Logiq P 6, and Toshiba Aplio MX, devices. All evaluations were started at the SFJs and completed at the very distal ends of the vein tracts. All branching variations detected at the thigh, knee, and leg levels were recorded.

Evaluation

The anatomic variations of 500 GSVs at the thigh, knee, and leg levels were defined, and their frequencies were cited. The study is descriptive in statistical terms. Thus, there is no control group. Due to the study's descriptive nature, no experimental or interventional methods were utilized. Percentage ratios and standard deviations (sd) were used for statistical evaluations of the findings.

Results

The Demographic Properties of the Patients

The mean age of the 250 patients included in the study was 33.3 ± 8.0 (sd) years, and the age range was 17 – 48 years. 54 patients were males, and 196 were females. The male / female ratio was 1 / 3.6. Patients were most frequently referred from cardiovascular and general surgery clinics.

Variations Demonstrated at the Thigh Level

Examinations of the 500 legs of 250 patients in our study disclosed all four but one variations described in the literature, this exception being the duplication variation. The frequencies of these four variations were as follows:

a) 48 GSVs were found to be coursing in the saphenous compartment, without any branchings (% 9.6) (Fig.1).

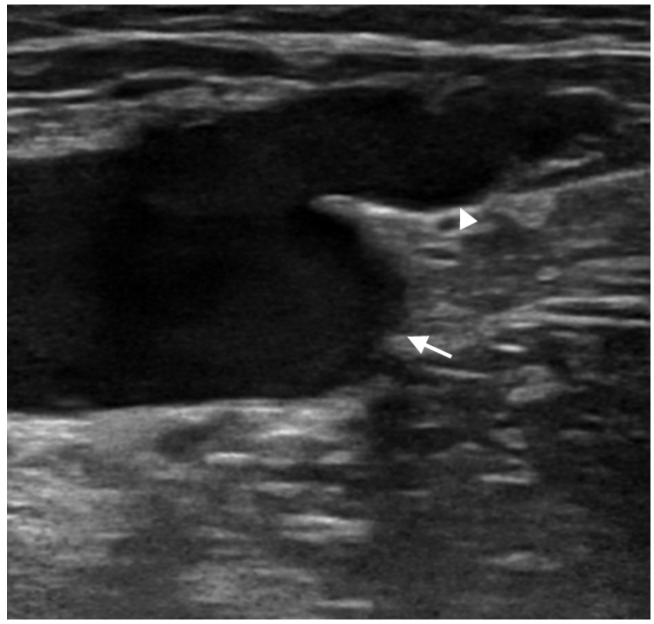

Fig 1. US image of great saphenous vein just before saphenofemoral junction without any branch. Also seen femoral vein (arrow: femoral vein, arrowhead: GSV).

b) A large branch which was not located in the saphenous compartment and which penetrated this compartment at some level, was found in 281 cases (%56,2) (Fig.2).

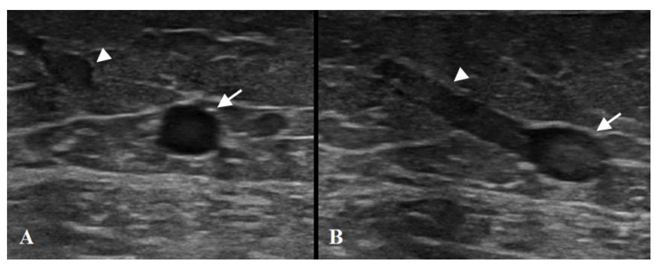

Fig 2. A tributary vein which was not located in the saphenous compartment draining to great saphaneus vein at some level of thigh (arrow: GSV, arrowhead: tributary vein).

c) In 148 cases, there were a GSV and anterior accessory saphenous vein (AASV) in the distal saphenous compartment, and these vessels were creating two distinct "eye signs" (Fig.3). Also, these veins were uniting to form a single vessel prior to joining the SFJ (%29,6)

Fig 3. GSV and AASV seen in two separate saphenous compartmant at the level of the distal thigh (arrow: GSV, arrow head: AASV).

d) A branch which was not located in the saphenous compartment was found to be draining into the GSV just before the SFJ, in 23 cases (%4,6) (Fig.4).

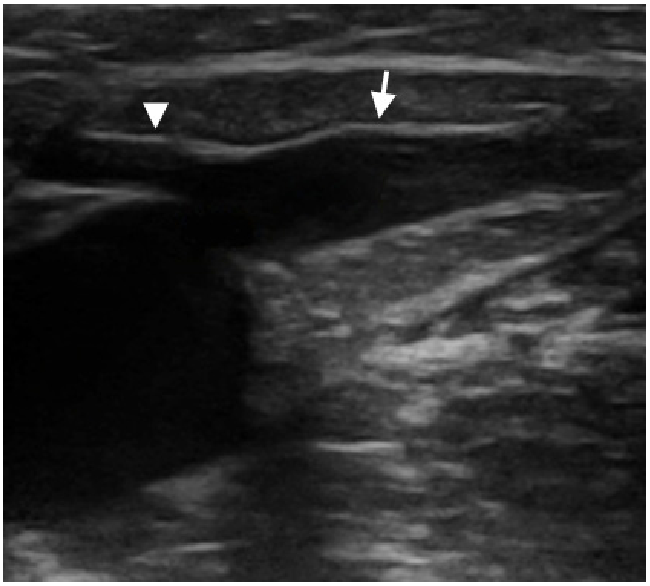

Fig 4. US image of a tributary vein draining to great saphaneus vein before saphenofemoral junction (arrow: GSV, arrowhead: tributary vein).

The thigh-level GSV variations of the 54 male and 196 female patients are listed in Table 1.

Table 1. Variations Seen at the Thigh Level

The thigh-level GSV variations	Male		Female	
	Number	Ratio	Number	Ratio
GSV, without any branchings	10	% 9.3	38	% 9.7
A large branch outside saphenous compartment	58	% 53.7	223	% 56.9
GSV with AASV	34	% 31.5	114	% 29.1
A branch draining into the GSV before the SFJ	6	% 5.6	17	% 4.3

Variations Detected at the Knee Level

Following the evaluation of the 500 GSVs, all of the 5 variation patterns described in the literature were found in our patients. These variations were as follows:

a) In the knee level, GSV was found without any branchings in 126 cases (%25,2) (Fig 5).

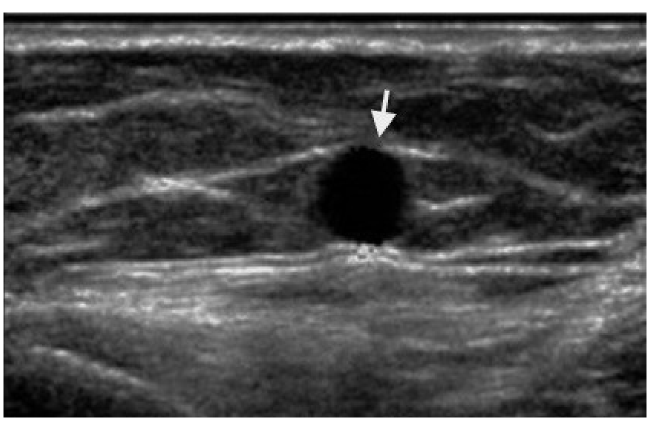

Fig 5. Great saphaneus vein at the knee level without any branching (arrow).

b) One or two tributary veins draining into the GSV below the knee were detected in 144 cases (%28,8) (Fig 6).

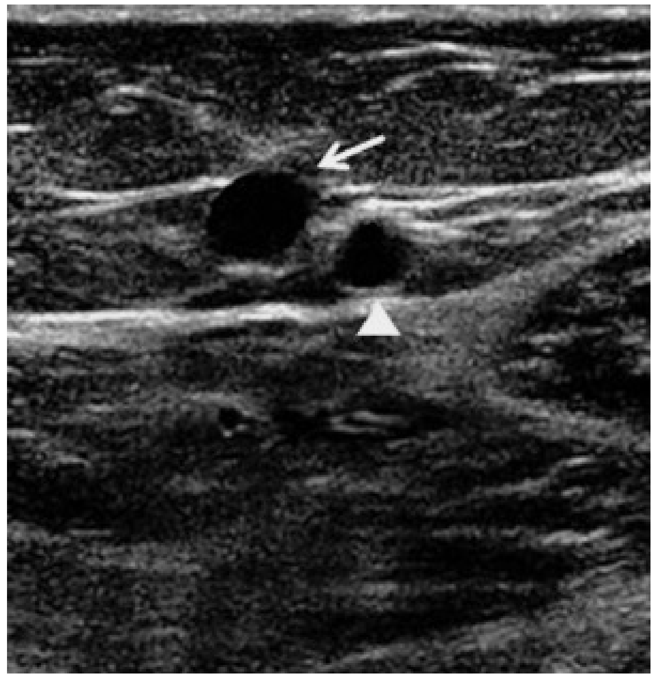

Fig 6. US image of a tributary vein and GSV below the knee (arrow: BSV, arrowhead: tributary vein).

c) A normally calibrated or varicose tributary vein was found to be draining into the GSV in 105 cases (%21,0) (Fig 7).

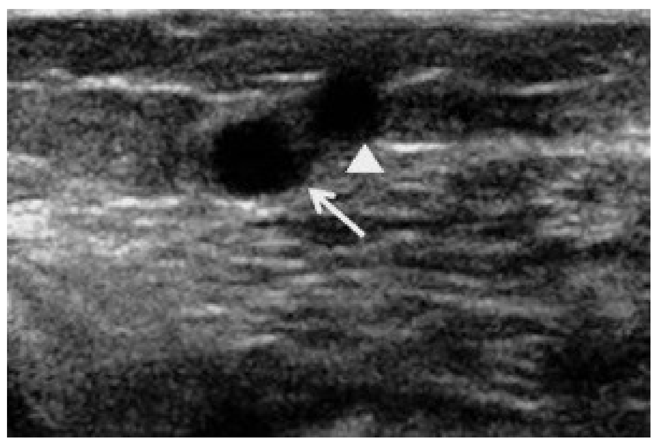

Fig 7. US image of a tributary vein and GSV at the knee level (arrow: BSV, arrowhead: tributary vein).

d) In 59 cases, the GSV was not visible at the knee level, and a subcutaneous tributary vein penetrating the fascia was found to be connecting the proximal and distal portions of the GSV (%11,8) (Fig 8).

e) In 66 cases, the pattern was very much similar to the one described above, except for the fact that the invisible GSV compartment was very short in these cases (%13,2).

The knee-level variations of the 54 male and 196 female patients are listed in Table 2.

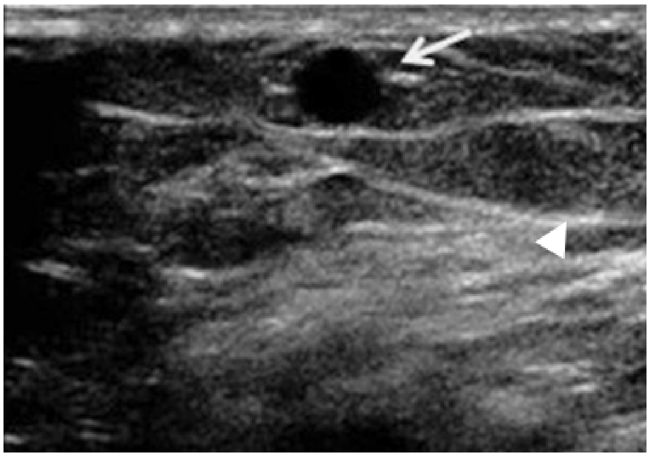

Fig 8. US image shows a superficial and subcutaneous tributary vein which is seen at the knee region (arrow), where GSV is not observed in the saphenous compartment.

Table 2. Variations Seen at the Knee Level

The knee-level GSV variations	Male		Female	
	Number	Ratio	Number	Ratio
GSV, without any branchings	26	% 24.1	100	% 25.5
tributary veins below the knee	31	% 28.7	113	% 28.8
tributary veins at the knee	20	% 18.5	85	% 21.7
Long invisible GSV	15	% 13.9	44	% 11.2
Short invisible GSV	16	% 14.8	50	% 12.8

Variations Detected at the Leg Level

After examining and evaluating all of the 500 GSVs, it was found that all 3 of the leg-level variations reported in the literature were present in our group too. These variations and their frequencies were as follows (Fig 9):

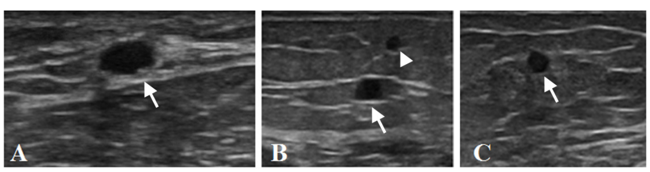

Fig 9. US images of variations at leg level;
A) I type: A single GSV is in saphenous compartment without branching (arrow)
B) H type: GSV in the saphenous compartment (arrow) and it's branch out of the compartmant (arrowhead)
C) S type: In this image which shows the middle part of leg, GSV is not visiable, but there is a tributary vein which is not in the saphenous compartment (arrow).

• I Type: A single GSV was found in 225 cases, coursing through the saphenous compartment with no distinct branching (%45,0).
• H Type: In 241 cases, a branch usually larger than the GSV itself was found to be coursing outside the saphenous compartment and draining into the GSV after penetrating the fascia (%48,2).
• S Type: A superficial branching was detected in 34 cases, which was penetrating the fascia and draining into the GSV. But a distinct feature was that the GSV was invisible beyond this level, and thus it was considered as hypoplastic or aplastic (%6,8).

The leg-level GSV variations seen in the 54 male and 196 female patients are listed in Table 3.

Comparison of variations for right and left lower extremities

The variation ratios for the right and left extremities in each 3 levels are listed in table 4.

Table 3. Variations Seen at the Leg Level

The leg-level GSV variations	Male		Female	
	Number	Ratio	Number	Ratio
Type I	55	% 51.0	170	% 43.4
Type H	50	% 46.2	191	% 48.7
Type S	3	% 2.8	31	% 7.9

Table 4. Variations ratios of right and left lower extremities

The thigh-level GSV variations	Right lower extremity		Left lower extremity	
	Number	Ratio	Number	Ratio
GSV, without any branchings	24	% 9.6	24	% 9.6
A large branch outside saphenous compartment	138	% 55.2	143	% 57.2
GSV with AASV	76	% 30.4	72	% 28.8
A branch draining into the GSV before the SFJ	12	% 4.8	11	% 4.4
The knee-level GSV variations	Right lower extremity		Left lower extremity	
	Number	Ratio	Number	Ratio
GSV, without any branchings	60	% 24.0	66	% 26.4
tributary veins below the knee	75	% 30.0	69	% 27.6
tributary veins at the knee	49	% 19.6	56	% 22.4
Long invisible GSV	34	% 13.6	25	% 10.0
Short invisible GSV	32	% 12.8	34	% 13.6
The leg-level GSV variations	Right lower extremity		Left lower extremity	
	Number	Ratio	Number	Ratio
Type I	117	% 46.8	108	% 43.2
Type H	118	% 47.2	123	% 49.2
Type S	15	% 6.0	19	% 3.8

Discussion

The GSV is the largest vein of the human body [5]. The vein courses along the medial aspects of the lower extremities [6]. The evaluation of the vein is usually accomplished using CDUS, which is a cheap but very effective modality in this aspect. Particularly, the vein's location inside the saphenous compartment and "Egyptian-eye" pattern caused by this location, are very typical of this vein, and thus, contribute to the practicality of this modality in the overall evaluation of the vessel [7,8].

Various anatomical variations may be encountered at the thigh, knee, and leg levels of the GSV tract. A good command of knowledge concerning these variations is mandatory for a thorough examination of the vessel anatomy and pathology, and also for a successful therapy [9].

Various anatomic variations of the GSV have been reported in the literature, at three levels of the vein tract. These are the thigh, knee, and leg levels [8]. Five variations have been defined at the thigh level, while four have been reported at both the knee and leg levels each. Many scientific reports in the literature have defined the frequencies of variations encountered in the knee region, but sufficient data is missing about the frequencies of variations seen at the thigh and leg levels [8,9,10]. A previous study evaluated a large series of the variations in the knee region [11], and results were similar to ours. In our study, substantial data is being given about the frequencies of variations concerning all of these three levels.

Two hundred and fifty patients were included in our study. Five hundred GSVs of these patients were examined, and each lower extremity was considered as an individual case. Our study has a

substantial number of patients when compared to most of the reports in the literature. 54 of these 250 patients were males, while 196 were females. The mean age of the patients was 33.3 ± 8.0 (sd) years.
In the previous studies, the ratios of variations between the men and women are not defined on 3 levels of lower extremity. Therefore, a comparison could not be made with the literature. In our study, there was no significant difference in the thigh and knee regions about the variations between males and females. However, with minor differences between genders, the type I variation at the leg level was %51 in males and %43.4 in females, S type variation was % 2.8 in males and % 7.9 in females. These findings suggest that gender differences, especially for the leg level, can be about GSV variations and this must be kept in mind in diagnostic and therapeutic evaluations. Also, the frequency of variations were compared according to the right and left lower extremities. There was no significant difference in all the variations at each 3 levels of extremities. Also, except S type variation of the leg, variations of an extremity was generally the same on the opposite extremity. However, S type variation of the leg was detected bilaterally in only 2 patients. According to findings, it should be taken into consideration while evaluating a patient, that especially the leg level variations may be different for both extremities.
It has been reported that a true duplication of the GSV is a very rare event [8,9,12,13]. This rare variation was not encountered in any of our cases.
Because of the lack of a thorough descriptive study reporting the variation frequencies of the GSV at all of these three levels, a satisfying comparison of our study results with those from the literature seems out of reach for the moment. But, some studies in the literature have reported rather similar frequencies of variations encountered at the knee level, and thus, our results concerning the same level could be compared with those findings. These comparisons disclosed similar results demonstrating harmony with those from the literature [8,9].

Conclusion

The results of our study clearly show that the GSV has a large number of variations at various levels of its track. A good knowledge of these variations is of utmost importance not only for a proper CDUS evaluation and diagnosis but also for a successful intervention to be performed by interventional radiologists.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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